Advanced Vehicle Testing Activity

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Idle Reduction Technology Demonstrations

STATUS REPORT

Ken Proc
National Renewable Energy Laboratory

U.S. Department of Energy
Energy Efficiency and Renewable Energy

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Executive Summary

The U.S. Department of Energy's (DOE) Advanced Vehicle Testing Activity (AVTA) initiated a study of diesel truck engine idle reduction technologies in 2002. As part of this study, AVTA is sponsoring three idle reduction demonstration projects, which consist of teams of a truck fleet, truck manufacturer, and idle reduction technology manufacturer. This report provides the status of the projects and identifies potential next steps based on early results.

A project led by Schneider National Inc. is demonstrating engine-off cab cooling and heating. In hot weather testing, trucks using an auxiliary cab cooler averaged 15% idle time (15% of the total operation time was spent idling), versus 19% for comparison trucks (trucks without auxiliary cab coolers). However, this reduction in idling did not result in a measured fuel economy improvement; an extension to this project will test a second cooling technology. In cold weather testing, trucks using an auxiliary cab heater averaged 9% idle time, versus 22% for comparison trucks, and averaged 2.0% better fuel economy than the comparison trucks. Based on these results, Schneider National is equipping all its new trucks and all its MY 2003 trucks with auxiliary cab heaters.

A project led by Caterpillar Inc. is demonstrating Caterpillar's MorElectric technology, which applies electrically driven accessories for cab comfort during engine-off stops and for reducing fuel consumption during on-highway operation. Engineering design work required for installation has been completed, and equipment has been installed at the truck factory. Collection of fuel, operation, and maintenance data is underway. A 2-year extension to this project will capture longer-term durability information and effects reduced idling may have on engine and engine accessory wear.

A project led by Espar Heater Systems is demonstrating a combined cab heating and cooling system. Engine pre-heaters also are being installed to reduce idling done to avoid cold-start problems. The project was awarded in Fall 2004, and installation of the heating and cooling equipment is underway.

In addition to the three demonstration projects, this report briefly describes other idle reduction activities, including DOE State Energy Program idle reduction projects and a DOE solicitation for projects to standardize installation of idle reduction technologies. A potential project to apply thermal management technologies to truck cabs is discussed, as is the multi-agency National Idle Reduction Plan.

Background

In 2002, DOE's AVTA initiated a study of diesel truck engine idle reduction technologies, which identified several barriers to widespread use of existing technologies. These barriers included initial cost, driver education and receptiveness, reliability, and maintenance requirements. The results of the study were used to develop a demonstration plan (www.avt.nrel.gov/pdfs/demo_plan_final.pdf) that defined a pathway to idle reduction technology implementation. The goal of the demonstration and evaluation effort outlined in the plan was to gather objective in-use information on the performance of available idle reduction technologies by characterizing the cost; fuel, maintenance, and engine life savings; payback; and user impressions of various systems and techniques.

Several phases of the demonstration plan have been completed, including a workshop for gathering industry input, held in April 2003 in Philadelphia. Input from the workshop was used to design a DOE solicitation for technology demonstration projects as well as help prioritize data types for collection and evaluation. A second workshop was held to identify cost reduction strategies; DOE subsequently released a technology introduction plan that outlines a path to implementation of these cost reduction strategies and refines the technology implementation strategies addressed in the earlier demonstration plan (www.orau.gov/idlingreduction/IRtechintroplan5-13-04.pdf). In late 2003, two idle reduction demonstration projects were awarded, and a third project was awarded in 2004. In-use evaluation of technologies has begun for the first two projects and recently began for the third. This report provides the status of the current projects and identifies potential next steps based on early results.

Demonstration Projects

The three projects consist of teams of a truck fleet, truck manufacturer, and idle reduction technology manufacturer. Including all the major participants on the teams ensures successful implementation and demonstration of the complete onboard idle reduction systems.

The first contract award, to Schneider National Inc., for a project titled "Cab Heating and Cooling," is demonstrating the Webasto Cab Cooler, which uses a phase change cooling storage technology to cool the truck cab when the engine is off. Nineteen Freightliner trucks were equipped with the Cab Cooler, and 100 trucks were equipped with a self-contained diesel-fueled air heater to demonstrate engine-off cab heating.

The second award, to Caterpillar Inc., for a project titled "Demonstration of the New MorElectric Technology as an Idle Reduction Solution," is applying electrically driven accessories for cab comfort during engine-off stops and for reducing fuel consumption during on-highway operation. International Truck is equipping five new trucks with the technology for operation by Cox Transfer.

The third award, to Espar Heater Systems, for a project titled "Idle Reduction Technology Demonstration and Information Dissemination," is demonstrating a combined heating and cooling system. At least 20 International trucks are being equipped with the system for operation by Wal-Mart Transportation, LLC. Espar engine pre-heaters also are being installed to reduce idling done to avoid cold-start problems.

Figure 1 illustrates the implementation schedule for data collection and demonstration activities. The teams led by Schneider National and Caterpillar are conducting data collection and demonstration activities that began in late 2003. The Espar team is beginning installation of heating and cooling equipment.

Figure 1. Data Collection/Demonstration Implementation Schedule

	FY 2003				FY 2004				FY 2005				FY 2006				FY 2007				FY 2008			
	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q
Schneider National Team			1.1	1.2	1.3		1.4		1.5	1.6														
Caterpillar Team				2.1	2.2	2.3	2.4		2.5						2.6					2.7				
Espar Team									3.1	3.2						3.3								

1.1 Schneider National project start and installation of cooling technology
1.2 Install on-board heaters for cold weather evaluation
1.3 Report on first season of warm weather operation (cooling technology performance)
1.4 Report on cold weather operation (heating technology performance)
1.5 Report on second season of warm weather operation (cooling technology performance)
1.6 Final analysis and results report
2.1 Caterpillar project start
2.2 Retrofit prototype truck with HVAC system (Truck #0)
2.3 Order first truck from International (Truck #1)
2.4 Evaluate and debug Truck #1; order remaining trucks
2.5 All ten trucks in service; start data collection
2.6 Report on first year of data collection and driver experience
2.7 Final analysis and results report
3.1 Espar project start and installation of bunk heaters and air conditioning systems
3.2 Report on data collection requirements and procedures
3.3 Final analysis and results report

Schneider National Project Status

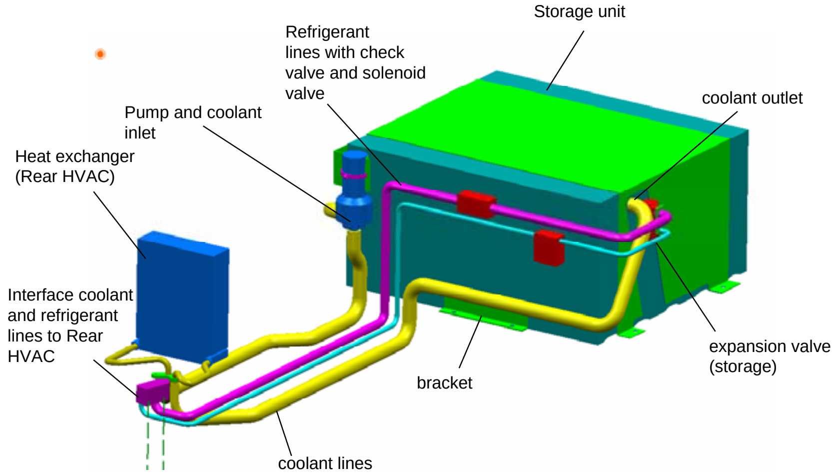
Schneider National leads this project, and its fleet is using the technology. Freightliner is the truck manufacturer, and Webasto Thermosystems Inc. manufactures the idle reduction technology. Schneider National, a Wisconsin-based provider of truckload and intermodal services throughout North America, takes a proactive stance to reduce idling in its fleet of 15,000 trucks. It offers incentives to its drivers to keep idling time to a minimum, and its trucks idle considerably less than the industry average: 480 hours/year vs. 1,830 hours/year for the industry. For this evaluation, Schneider National chose to demonstrate the heating and cooling technologies separately, taking advantage of climate extremes in collecting evaluation data. To date, Schneider National has completed a first round of hot weather testing as well as a winter of cold weather testing. Data on system operation were collected using temperature data loggers and driver records for hours of operation. Some of the preliminary results are presented here.

Hot Weather Testing

Cooling performance (hot weather) testing was conducted with 19 trucks based out of Schneider National's Dallas facility, operating primarily in the Southwestern United States. Schneider National's Freightliner trucks operated from June to September 2003. The technology evaluated was Webasto's Cab Cooler (Figure 2), retrofitted to existing trucks in Schneider National's fleet. The Cab Cooler uses a thermal storage medium to collect cooling energy during normal daytime operation. The system stores cooling from the truck's normal cab air conditioning unit while in operation during driving, then provides cooling during non-driving hours by releasing the stored cooling via a heat exchanger and blower unit. Charging of the Cab Cooler takes up to 6 hours during normal driving. The retrofit also included installation of an insulating curtain to help isolate the sleeper bunk at night.

Preliminary Results Summary. With the goal of providing 10 hours of engine-off cooling capacity, the Cab Cooler performed satisfactorily in ambient temperatures up to 85°F. Above 85°F, the performance of the cooler degraded; for example, at 90°F, the cooler had sufficient capacity for 7 hours of operation. Performance declined proportionally as ambient temperature rose.

Figure 2. Webasto Cab Cooler



Trucks used for comparison during the evaluation period averaged about 19% idle time (19% of the time of total operation was spent idling). Schneider National's goal for idle reduction technology is to reduce idle time to 5%. In this test, the Cab Cooler reduced idle time to about 15%, on average, over the summer evaluation period (Figure 3). However, this reduction in idle time did not result in increased fuel economy compared with the control trucks (Figure 4). Additional testing will be necessary to investigate potential fuel economy impacts.

Figure 3. Idle Time of Test (Cooler) vs. Control Trucks

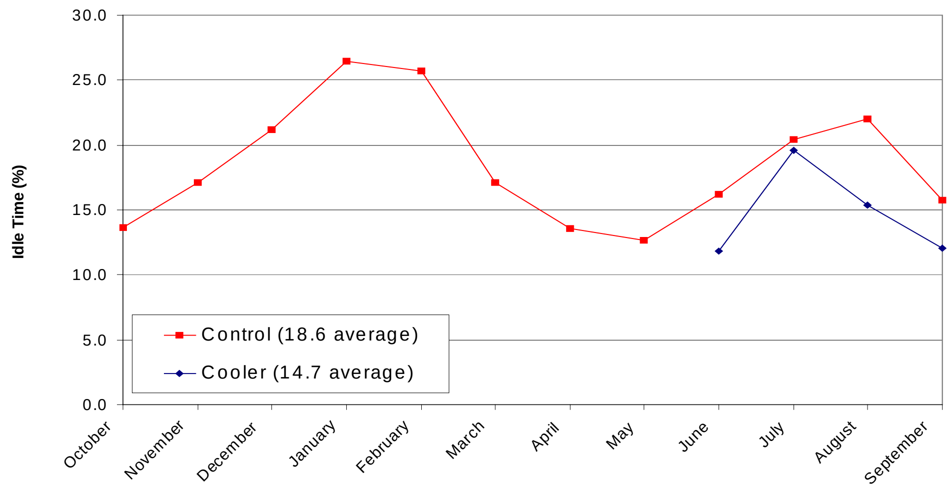
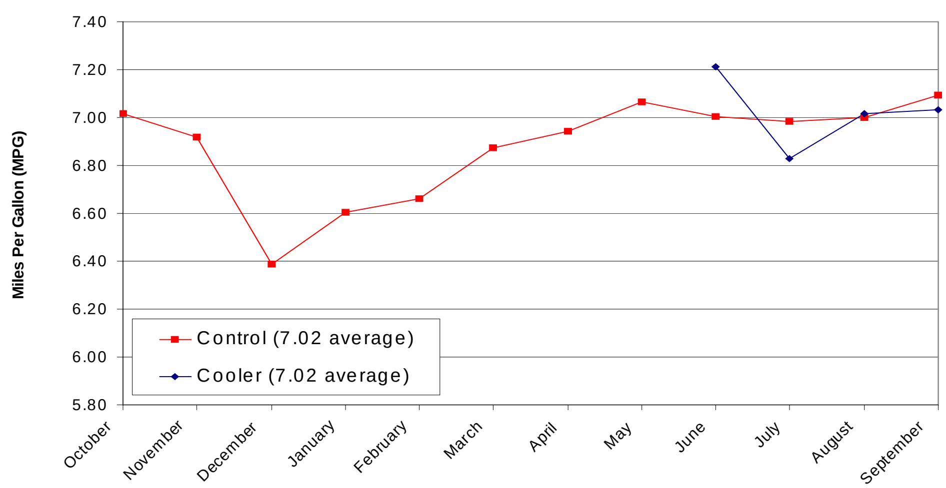


Figure 4. Fuel Economy of Test (Cooler) vs. Control Trucks



Drivers were asked to rate the cooling system on a scale of 1 to 5, with 3 representing a neutral rating and 5 representing an exceptional performance rating. The average driver rating was 4, and driver comments about the system were generally positive. The following are examples of the comments received:

- Operated through summer with no failures
- No electrical or battery issues came up during test
- Noise level is acceptable
- Had to keep fan on low speed to avoid low-power cutoff
- Heat migrating in from under bunk and side walls was a major limiter to performance
- Better air flow would improve performance
- Cannot use during the day when sun is out; cannot overcome radiant heat.

Issues. The most frequently reported issue from the drivers was lack of insulation allowing substantial heat migration through the walls of the truck. On hot days and nights, drivers reported heat coming up through the mattress and the surrounding walls, causing discomfort in the sleeper area. Adding to discomfort in the sleeper area, many drivers also reported a lack of airflow, especially at the head area (where the HVAC and other controls are located). Apparently, ducting of cooling air is directed toward the foot end of the bunk and not evenly distributed.

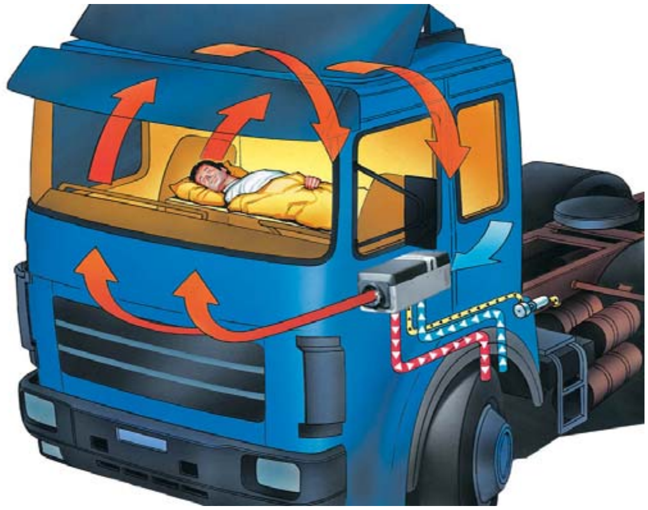
Additional issues with the system included complication of installation. Because this system was installed on existing trucks in operation in Schneider National's fleet, modifications had to be made to accommodate the Cab Cooler. The system had to be integrated with the existing air conditioning system, requiring highly skilled technicians to make the plumbing and electrical connections. According to Schneider National, the average time for an installation exceeded 30 hours (partly due to lack of familiarity with the system).

Because the Cab Cooler did not result in a significant reduction in fuel use (measured as fuel economy) in this test, and the installation (labor) costs were high, the projected payback period for this technology would exceed the industry-accepted 2-year maximum. Additional field testing is required to determine if an increase in fuel economy corresponding to the observed reduction in idling can be achieved. If this could be achieved, and Webasto was able to achieve its target of a $1,200 factory installation price for the Cab Cooler, the payback period could become acceptable for fleets with idle rates closer to the industry average (Schneider National trucks already idle 73% less than the industry average; trucks with higher idle times have higher potential benefits from idle reduction technologies).

Cold Weather Testing

Heating performance (cold weather) testing was conducted with 100 trucks operating out of various Schneider National operating facilities for the period November 2003 to April 2004. The technology evaluated was Webasto's Airtop 2000 cab heater. The unit is a self-contained diesel-fueled air heater installed in the existing truck ductwork to circulate heated air (Figure 5). It draws fuel from the truck's diesel tanks. Drivers can adjust the temperature via a thermostat, and the heater is operated on a 10-hour timer to prevent continued operation while driving (the timer can be reset if a stay is longer than 10 hours). The heater units were retrofitted to existing Freightliner trucks in Schneider National's fleet without any additional modification to the truck cab or sleeper bunk (no insulating curtain installed).

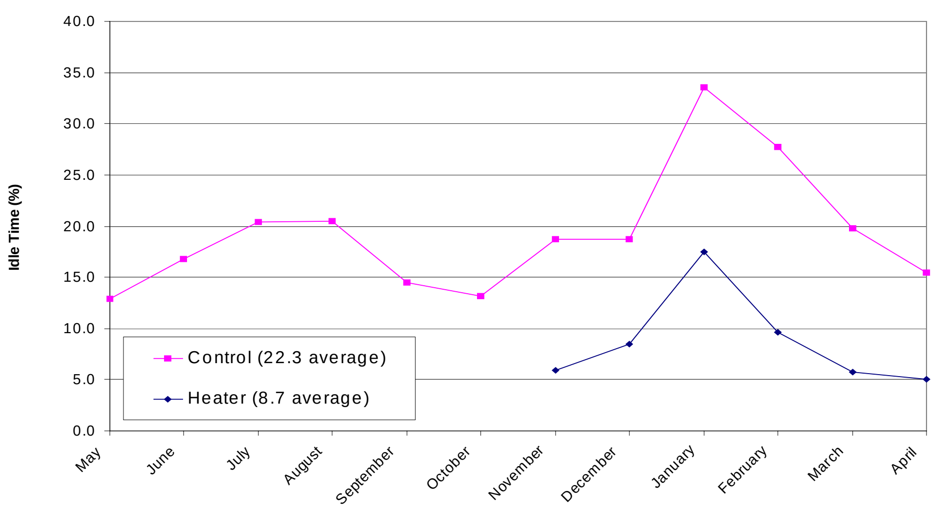
Figure 5. Airtop 2000 Cab Heater Operation



Preliminary Results Summary. The heaters met Schneider National's performance requirements by keeping the truck cab heated to 70°F in ambient temperatures above 10°F. Below 10°F, Schneider National's policy is to idle a truck if it will be parked for more than 8 hours to avoid cold-starting problems. In testing, the Airtop 2000 exceeded requirements, keeping the cab at 70°F in ambient temperatures down to 0°F. Of the 100 units installed, five problems that required service were reported during the evaluation period; these problems were related to incorrect installation of wiring and a faulty glow pin (ignition device).

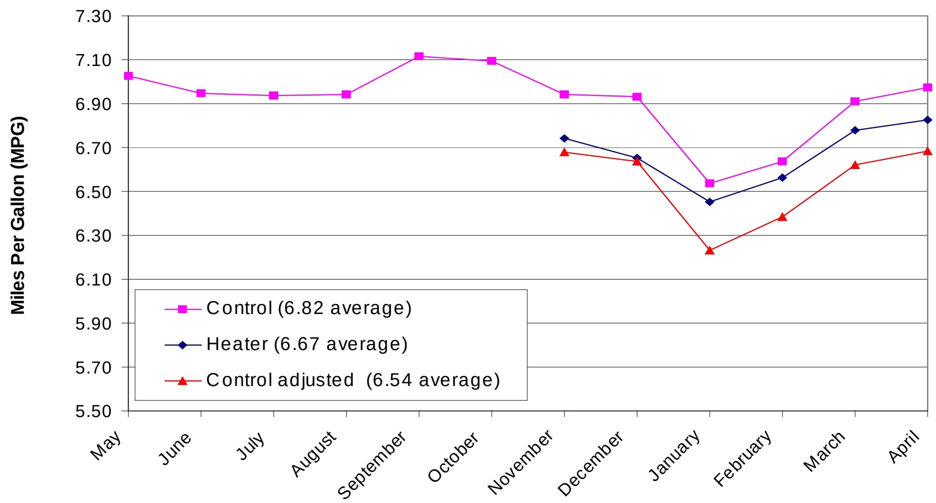
Trucks used for comparison during the evaluation period averaged 22% idle time. The test trucks averaged 9% idle time and approached the goal of 5% idle time in all but the extreme temperature months of December, January, and February (Figure 6). In these cold months, more idling was necessary to avoid cold-starting problems.

Figure 6. Idle Time of Test (Heater) vs. Control Trucks



Fuel economy results were also positive. The test trucks, which were equipped with exhaust gas recirculation (EGR), averaged 6.67 mpg over the evaluation period. From Schneider National field data, EGR reduced fuel economy by 4.1%. The control trucks were not equipped with EGR, so their fuel economy results were reduced by 4.1% to enable a reliable comparison with the test trucks. Taking this adjustment into account, the test trucks averaged 2.0% higher fuel economy than the control trucks (Figure 7).

Figure 7. Fuel Economy of Test (Heater) vs. Control Trucks



Issues. The issues with the Airtop 2000 were minor, and the results were generally positive. The drivers reported a lack of temperature range adjustment, which made the cab somewhat warm for those who prefer a cooler sleeping environment.

Payback period based on fuel savings alone (at $1.50 per gallon) is less than 4 years based on Schneider National's idling data. At higher fuel prices, or for fleets with higher (closer to industry average) idling time, the payback period could be 2 years or less (the industry-accepted payback period for a truck accessory such as idle reduction technology).

Future Plans

With the success and positive results of the cold weather testing, Schneider National decided all of its new trucks will have an auxiliary heater. The Webasto Airtop 2000 is available from Freightliner as a factory-installed option. Schneider National is retrofitting all of their MY 2003 trucks with the heaters as well. Evaluation of the heaters will continue through the next cold weather season to investigate longer-term durability and reliability of the Airtop 2000.

In Fall 2004, DOE awarded an extension to the Schneider National project to include testing of a second cooling technology. This proposed unit, manufactured by Bergstrom, operates on 12 VDC power during engine-off conditions to cool the truck sleeper without idling the main engine.

Caterpillar Project Status

Caterpillar Inc. leads this team and manufactures the idle reduction technology. International is the truck manufacturer, and Cox Transfer is the fleet that will use the technology. Cox Transfer is an Illinois-based truckload and flatbed common and contract carrier whose 100 trucks idle approximately at the DOE-reported average of 1,830 hours per year. The system being evaluated is Caterpillar's MorElectric technology. MorElectric consists of an auxiliary power unit (APU); a heating, ventilating, and air conditioning (HVAC) unit; and a high-efficiency generator that replaces the alternator (Figure 8). These components form a system that is intended to reduce fuel use during on-highway truck operation and during rest periods when the truck normally idles. The electrically driven HVAC unit eliminates the need for an engine-driven air conditioning compressor. During rest periods, the same HVAC unit can be powered by the APU instead of the electrical power coming from the engine-mounted generator. The system also can be plugged in at truck stops that have electrical service, eliminating all fuel consumption during rest periods.

Figure 8. Caterpillar MorElectric System

For this project, Cox Transfer ordered 10 new trucks from International. Five of the trucks will serve as test vehicles, the other five as a control group. For the first truck, International installed the MorElectric system at its truck engineering center in Fort Wayne, Indiana; for the remaining four trucks, the MorElectric system was installed at International's assembly plant in Chatham, Ontario, Canada. The project schedule has been dictated by the truck production and system installation schedule, and, to date, the first of the five test trucks has been built and is undergoing initial validation testing (Figure 9). The five control trucks have been built and are beginning freight operations, and the remaining four test trucks are scheduled to enter service by the end of October 2004 (Table 1).

Figure 9. First Production Test Truck

Table 1. Test Truck Production Schedule

Build	Days to Build	Build Start	Build Finish	System Check	Ready to Ship
Truck #2	10	8/16/04	8/27/04	8/30 to 9/10	9/13/04
Truck #3	10	8/30/04	9/10/04	9/13 to 9/24	9/27/04
Truck #4	10	9/13/04	9/24/04	9/27 to 10/8	10/11/04
Truck #5	10	9/27/04	10/8/04	10/11 to 10/12	10/13/04

Caterpillar and International have completed the engineering design work required for installation. A two-piece HVAC design was used on these test trucks to minimize vehicle modifications and to address weight distribution issues. Use of the standard one-piece HVAC unit would require relocation of one of the truck fuel tanks, changing the truck weight distribution and reducing trailer payload capacity. To keep the standard tank configuration and minimize truck cab modification, the design team decided to split the HVAC function with air handling done by the standard production fans, ducting, and water heat exchangers.

Future Plans

Caterpillar and the project team are on schedule to begin data collection from the test trucks in October 2004. Fuel, operation, and maintenance data will be collected regularly from the test and control trucks for direct comparison. Data items such as fuel and oil consumption, preventive maintenance, and repairs will be used to quantify operating costs. Engine and vehicle maintenance data will be collected in addition to idle reduction system maintenance data to quantify any effects the MorElectric system may have on reducing truck maintenance from less engine idling.

In Fall 2004, DOE awarded an extension to the Caterpillar project for an additional 2 years to capture longer-term durability information and any effects reduced idling may have on engine or engine accessory wear. The team is also expanding engine oil analysis to help quantify these possible engine effects as well as analyzing the APU oil to help predict the long-term durability and wear of the APU.

Espar Project Status

Espar Heater Systems was awarded the third idle reduction demonstration project in fall 2004. Espar manufactures truck cab heating and cooling systems that can reduce truck idling. Espar's team includes International as the truck manufacturer and Wal-Mart Transportation, LLC as the fleet operator. The team will install Espar systems that provide combined heating and cooling on at least 20 trucks operating across the United States. Espar engine pre-heaters also will be installed to reduce idling done to avoid cold-start problems.

Status of Other Activities

Driver Questionnaire

Driver acceptance is crucial for widespread use of technologies that reduce truck idling. In June 2004, the AVTA team developed a driver questionnaire to be administered to truck drivers involved in the idle reduction technology demonstration projects. These 22 questions are intended to help capture user impressions of the various technologies being tested as well as identify specific barriers to acceptance of a particular system or technology. The questionnaire is to be administered by the project fleets in November 2004, with results published in early 2005. Details of the questionnaire are in Appendix A.

State Energy Program Special Projects

DOE's State Energy Program (SEP) provides funding to states for renewable energy and energy efficiency projects (see www.eere.energy.gov/state_energy_program). An SEP solicitation issued by DOE's Clean Cities Program in January 2004 included funding opportunities for idle reduction projects. In August 2004, DOE announced three truck idle reduction projects would be funded by the SEP (with funds provided by Clean Cities and AVTA): a shore power project in California, an APU (Pony Pack) data collection project in New Mexico, and an infrastructure deployment project in New York. Addition details on the program and these awards can be found at www.eere.energy.gov/cleancities/financial.html.

Installation of Idle Reduction Technologies

DOE is interested in funding the costs for standardizing installation of idle reduction technologies to reduce the buyer's initial cost for an idle reduction system. In fall 2004, DOE issued a solicitation for projects that will design, engineer, and install on-board idle reduction technologies on the production line of a truck manufacturer. The idle reduction system proposed will be made available as a factory option, with a goal of having units in operation by 2007. Applicants should consist of teams of a truck manufacturer, an idle reduction technology manufacturer, and a truck fleet interested in purchasing and operating new trucks equipped with an idle reduction system. A cost share of 50% is required. More information is available at https://e-center.doe.gov/iips/faopor.nsf/8df825feb86675de852564650046faea/433711f2c0d8f3ad85256f0a006dfad4?OpenDocument.

Next Steps

As final results from the idle reduction technology demonstration projects become available, DOE will publish reports documenting the in-service performance of the tested technologies. These results will quantify the cost and reliability, identify potential barriers to widespread use, and help analyze the payback period for an idle reduction technology installation. The reports will provide information to other truck fleets and owner-operators considering the purchase and use of idle reduction technologies. As preliminary results are received, the AVTA team will continually investigate issues discovered in the demonstration projects to define future activities in support of reducing truck idling and its resulting fuel use.

CoolCab

Early results from the current demonstration projects have identified key issues with truck cab insulation that warrant further investigation. Drivers complained of heat penetrating the cab walls, causing discomfort and reducing the effectiveness of the cooling equipment. The heat penetration was most noticeable on sunny days. This insulation issue has been discussed at idle reduction workshops and was identified as a major issue needing further research and development at the National Idling Reduction Planning Conference in Albany, NY. Manufacturers claim that improving insulation and reducing the cooling or heating load can substantially decrease the size, cost, and weight of their idle reduction technologies.

AVTA has proposed a load reduction project for future DOE funding, which will apply past experience with light-duty vehicle interior thermal management to heavy-duty truck tractor cabs. Called CoolCab, this effort would use a “systems approach” to investigate thermal loads on the vehicle, effective delivery methods, and efficient equipment. Simple solutions, such as adding insulation to a truck cab or special glazing on windshields, could significantly reduce the cooling or heating load on the vehicle and thus reduce fuel use. The team is currently investigating interest in the project from industry and potential partners.

National Idle Reduction Plan

DOE is working with the Environmental Protection Agency (EPA) and the Federal Highway Administration (FHWA) to develop a national idle reduction plan. The goal of this effort is to define activities promoting the introduction of idle reduction strategies and technologies. Clean Cities is also involved to help plan how results from demonstration projects and information from other idle reduction activities get disseminated. Steering committees are now being formed, and a draft of the plan is anticipated in February 2005. AVTA will support development of this plan through sharing of information and knowledge gained through the technology demonstration projects. For information about the abovementioned organizations’ idle reduction activities, visit the following Web sites: EPA www.epa.gov/otaq/smartway/idling.htm, FHWA www.fhwa.dot.gov/environment/cmaqpgs, Clean Cities www.eere.energy.gov/cleancities/idle, AVTA www.avt.nrel.gov/idle.html.

DRIVER SURVEY:
FLEET DEMONSTRATION OF IDLE REDUCTION TECHNOLOGIES

JUNE 7, 2004

Driver acceptance is critical to successfully encourage the use of idle reduction technologies in heavy duty trucks. This survey was developed to ascertain users' perceptions of idle reduction technologies during fleet demonstrations. The information gathered herein will help to identify any remaining barriers from the users' standpoint and how they may best be overcome.

DRIVER HISTORY PRIOR TO THIS DEMONSTRATION PROJECT FOR IDLE REDUCTION TECHNOLOGIES

1. Prior to this demonstration project, did you track idling time? ❑ Yes ❑ No

2. Why historically have you idled your sleeper vehicle? (Please provide ESTIMATED percentage for each of the following. Total should equal 100%.)

   ___ Heat the cab? ___ Cool the cab? ___ Keep the engine warm?
   ___ Stopped in traffic? ___ Other? (specify) ______________________

3. Please ESTIMATE how many hours per year your sleeper vehicle has typically idled for each of the following:

   ___ Truck stops? ___ Rest stops? ___ In traffic?
   ___ Loading/off loading? ___ Other? (specify) ______________________

4. Prior to this demonstration, have you used idle reduction technologies? ❑ Yes ❑ No

   If yes, what type of technology have you used and who was the manufacturer?

		Manufacturer
Automatic engine shutdown	❑	______________
Diesel fired heater	❑	______________
APU (heating/cooling/electrical)	❑	______________
Genset	❑	______________
Truck stop electrification system	❑	______________
Other	❑	______________

   If no, why haven't you used idle reduction technologies?

   ____
   ____
   ____

5. If you answered yes to Question #4, what was your experience with these idle reduction technologies?

____

____

____

____

QUESTIONS REGARDING THIS DEMONSTRATION PROJECT OF IDLE REDUCTION TECHNOLOGIES

6. For this demonstration, what type of idle reduction technology are you using? Who is the manufacturer(s) and how long have you been using it?

		Manufacturer	How Long
Diesel fired heater	❑		
APU (heating/cooling/electrical)	❑		
Genset	❑		
Phase change system	❑		
More electric truck system	❑		
Other ____________________	❑		

7. This question addresses driver comfort. Has the idle reduction technology during the demonstration:

   a) Provided sufficient heat during cold weather? ❑ Yes ❑ No ❑ N/A
   If no, please explain. ______________________________

   ____

   ____

   b) Provided sufficient cooling during hot weather? ❑ Yes ❑ No ❑ N/A
   If no, please explain. ______________________________

   ____

   ____

   c) Provided reliable heating functions through the year? ❑ Yes ❑ No ❑ N/A
   If no, please explain. ______________________________

   ____

   ____

   d) Provided reliable cooling functions through the year? ❑ Yes ❑ No ❑ N/A
   If no, please explain. ______________________________

   ____

   ____

8. What has been the effect of idle reduction technologies during this demonstration on your sleeping in the cab?

   ❑ Made it better
   ❑ Made it worse
   ❑ About the same
   Please explain. ______________________________

____

____

9. Has the idle reduction technology taken up too much space within the cab? ❑ Yes ❑ No

   If yes, please explain. ______________________________

____

____

10. Has the weight of the idle reduction technology impacted your ability to carry a full load? ❑ Yes ❑ No

    If yes, please explain. ______________________________

____

____

11. Has the idle reduction technology provided flexibility for additional driver amenities you find useful? For example, electrical power to run larger refrigerators, microwave, or lap top computer? ❑ Yes ❑ No ❑ N/A

    Please explain. ______________________________

____

____

12. In your opinion, can the idle reduction technology provide useful backup power during a failure of the main truck engine? ❑ Yes ❑ No ❑ N/A

    Please explain. ______________________________

____

____

13. Was training on the idle reduction technologies for this demonstration project quick and easy? ❑ Yes ❑ No

    If no, please explain. ______________________________

____

____

14. Is the idle reduction technology easy to operate? ❑ Yes ❑ No

    If no, please explain. ______________________________

____

____

15. Has the idle reduction technology required maintenance on the road? ❑ Yes ❑ No

    If yes, please explain. ______________________________

16. What has been your overall experience with idle reduction technology during this demonstration?

17. Would you like to continue to use this idle reduction technology after the conclusion of the demonstration? ❑ Yes ❑ No

    Please explain. ______________________________

18. If you perceive the following items (or others) as barriers to the adoption of idle reduction technologies, please rank them.

    ____ Cost
    ____ Weight
    ____ Maintenance (breakdown)
    ____ Driver training/education/acceptance
    ____ Performance
    ____ Maintenance (regularly scheduled)
    ____ Parts/distribution network
    ____ Lack of warranty
    ____ Other ______________________________

19. Are there additional comments (positive or negative) you would like to make with regards to idle reduction technologies and this demonstration?

    Please elaborate. ______________________________

20. What information would you personally need to make a decision on using idle reduction technologies? Please mark all that apply.

a) Experience of peer/colleagues? ❑
b) Results of long term (2 winters) test for reliability/durability? ❑
c) Cost/payback period? ❑
d) Extent of dealer/OEM support network? ❑
e) Other? ________________________________ ❑

____

____

21. Please check all that apply and rank in order of priority your primary sources of information on truck technology and related areas.

	Rank
❑ Truck manufacturers	____________
❑ Federal Government	____________
❑ Associations	____________
❑ Engine manufacturers	____________
❑ Industry trade publications	____________
❑ Other Sources	____________

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22. Please check all that apply and rank in order of priority the following means through which you prefer receiving information on truck technologies and related areas.

	Rank
❑ Industry conferences	____________
❑ Industry trade publications	____________
❑ Government publications	____________
❑ Electronic newsletter	____________
❑ World wide web/internet	____________
❑ Other	____________

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